FIG. 3 is a fragmentary frontal elevation of an anti-torque spline of the present invention taken along the section line 3—3 of FIG. 2.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to FIG. 1, a turbine engine 10 includes as its principal components one or more compressors 12, 13, one or more turbines 14, 15 for powering the compressors, a combustion chamber 16, a fan 18, a primary exhaust 20 and a fan exhaust nozzle 22. A shaft such as shafts 24, 25 extends from each turbine to drive the corresponding compressor. The rotary motion of one of the compressors is conveyed to the fan 18 by way of a planetary gear train 26 in a manner more completely described hereinafter. The planetary gear train reduces the rotational speed of the compressor to a speed more suitable for the efficient operation of the fan. The principal engine components are ideally concentric with a central longitudinal axis 28.

FIG. 2 shows the planetary gear train 26 of FIG. 1 and its relationship to the engine and to the coupling system of the present invention in greater detail. The forward end of the compressor drive shaft 24 is joined by splines 30 to the aft end of a sun gear coupling 32. The forward end of the coupling is joined, also by a spline 34, to the sun gear 36 of planetary gear train 26. Rotary motion of the shaft is thus transferred to sun gear 36. The sun gear meshes with multiple planet gears, of which the illustrated planet gear 40 is representative. Each planet gear is rotatably mounted in planet carrier 42 by a journal pin 44 or other suitable bearing so that rotary motion of the sun gear urges each planet gear to rotate about its own longitudinal axis 46. Each planet gear also meshes with a nonrotating ring gear 48 mounted in a ring gear housing 50 by splines 52. A ring gear coupling 54 joins the ring gear housing to a mechanical ground. In the illustrated embodiment the ground is a nonrotating roller bearing support 56, but can be any ground capable of resisting rotation of the housing and hence of the ring gear. Since the planet gears mesh with both the nonrotating ring gear and the rotating sun gear, the planet gears not only rotate about their own axes 46 but also orbit the sun gear causing the planet carrier 42 to rotate about axis 28. The planet carrier motion is conveyed to the fan 18 (FIG. 1) by any suitable means, not shown.

The coupling system of the present invention includes the sun gear coupling 32 and the ring gear coupling 54. The sun gear coupling has an inflexible spindle 60 and at least one undulant flexible section 62. The flexible section includes a cylindrical ring 64 with drain holes 65 distributed around the circumference of each ring so that any oil which inadvertently leaks into the interior of the undulant section will not accumulate therein and cause a rotary imbalance. The ring has a diameter greater than that of the spindle, and is joined to the spindle by longitudinally spaced diaphragms 66 and 68. The junctures 70 between the diaphragms and the spindle as well as the junctures 72 between the diaphragms and the ring, have a curved cross sectional profile to improve the flexibility of the coupling and minimize stress concentrations at the junctures. A single flexible section is adequate for accommodating angular misalignment between the sun gear 36 and the shaft 24. Two or more longitudinally spaced apart flexible sections are used for accommodation of parallel misalignment or a combination of angular and parallel misalignment. The splines 30 and 34 at either end of the coupling do not contribute materially to the flexibility of the coupling; rather the coupling derives its flexibility primarily from the undulant sections. The torsional rigidity of the ring 64 and spindle 60 make the coupling rigid with respect to torsion about the longitudinal axis. In addition, the undulant character of the flexible section makes the coupling compliant with respect to torsion about vertical and lateral axes (i.e. with respect to angular misalignments in a horizontal plane and in a vertical plane parallel to axis 28) and with respect to translation about all three axes. Accordingly, the coupling transmits high torque while isolating the gear train from forces and moments arising from misalignments between the sun gear and the external shaft.

The sun gear coupling is longitudinally retained by a nut 80 threaded onto the forward end of the coupling. The nut seats against a forward shoulder 82 on the sun gear thereby urging shoulder 86 on the coupling into contact with aft shoulder 84 on the sun gear. Contact between the forward shoulder and the nut prevents aft longitudinal displacement of the coupling while contact between the cooperating shoulders 84, 86 prevents forward longitudinal displacement of the coupling.

It may be desirable to use the interior of the sun gear coupling as an oil supply conduit, for example to deliver oil rearward to spline 30. The sun gear coupling may therefore include a flexible tubular insert 90 having an inlet 92 and an outlet 94. Oil, not shown, is supplied to the inlet by passages 96 and is centrifuged radially outward by the rotation of the coupling and insert, so that the oil forms a film on the inner surface 98 of the insert. The maximum depth of the film is limited to the height 100 of a lip 102 at the inlet. The interior diameter of the insert may be constant, but ideally the diameter increases continuously from the inlet to the outlet to s encourage the centrifuged oil to flow longitudinally rearward rather than forward. A snap ring 104 disposed in an annular slot around the interior of nut 80 bears against a forward flange 106 of the insert to provide longitudinal retention thereof within the interior of the spindle. Forward and aft standoffs 110 and 112 each form a ring around the circumference of the insert to support it radially within the coupling. The surfaces 114 and 116 of the standoffs are spherical so that they will roll along the inner wall 120 of the coupling and not resist the flexure thereof. Each spherical surface also has a groove 122, 124 within which a seal ring 125, 127 is disposed to prevent oil leakage into the undulant sections. A group of elbows 130 associated with each of the undulant flexible sections extends through the wall of the insert so that the interior of each undulant section can be readily inspected with a flexible optical instrument, not shown. The optical instrument is inserted longitudinally along the coupling, and into the mouth 132 of an elbow. Further insertion of the instrument causes it to follow the contour of the elbow and bend radially outward so that the interior of the diaphragms 66, 68 and the ring 64 can be easily viewed. The mouth of each elbow is radially spaced from the inner surface 98 of the insert by a distance equal to at least the radial height 100 of lip 102. This ensures that the oil film, whose radial depth will be no larger than height 100, will not be captured by the mouth and centrifuged into the interior of the undulant section where it can cause a rotary imbalance. In the preferred embodiment, three elbows are used at each undulant section, however any number of elbows greater than or equal to two can be